

Minutes of the Eastham Water Management Committee Meeting of January 17, 2018

Chair Adele Blong called the meeting to order at 2:32pm in the Earle Mountain Room of Town Hall. Present also were members Roberts, Lewis, Bumby, Harris and Bryan.

Any documents distributed prior to or during this meeting are listed at the end of these minutes.

This meeting is a joint meeting of the Eastham Board of Selectmen, Eastham Water Management Committee and the Eastham Board of Health. This meeting was chaired by Selectman Adams who stated that the purpose of the meeting was to receive and discuss the report of Solitude Lake Management consultants on water quality as it relates to Minister/Schoolhouse Pond.

Minutes of the discussion of this joint meeting were provided by the Board of Selectmen Clerk.

Documents distributed prior to or during this meeting:

Aquatic Evaluation at Minister/Schoolhouse Pond October 2017

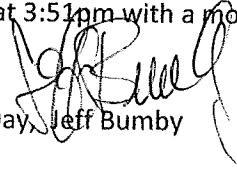
Ecologic Memorandum

Action Plan for Schoolhouse Pond

Action Plan for Minister Pond

Letter from Bayberry Hill Condominium Assoc.

The Water Management Committee was adjourned at 3:51pm with a motion from Bumby and a second from Harris.


Clerk of the Day, Jeff Bumby

Aquatic Evaluation at Minister/Schoolhouse Pond

2017 Final Report

October 2017



Prepared For:

Town of Eastham
c/o Jane Crowley, Health Dept.
Eastham, MA 02642



Prepared By:

SOLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

SOLITUDE
LAKE MANAGEMENT

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- Appendix A – Raw Data
- Appendix B – Algae ID & Enumeration Report



INTRODUCTION

SÖLitude Lake Management (SÖLitude) was contracted by the town of Eastham to assess the existing aquatic growth and water quality conditions within Minister/Schoolhouse Pond due to concerns with the effects of watershed development and runoff into the ponds.

The 22.3-acre pond is comprised of two basins located in Eastham, MA. The pond is commonly called Minister Pond, but has a lower basin often individually referred to as Schoolhouse Pond. Water flows into the Minister basin and out through the Schoolhouse basin. The basins have adequate depth for their size, 16.8 acres and 5.6 acres respectively, with a maximum reported depth of 4.30 meters in the Minister basin and 4.54 meters in the Schoolhouse basin. According to StreamStats, nearly the entire watershed is residentially developed, potentially contributing to nutrient influx into the pond. In 2009, an assessment of the Eastham ponds was directed by the Town and Cape Cod Commission, founding the need for remediation of Minister/Schoolhouse Pond.



The Town of Eastham is pursuing a study and management program of Minister/Schoolhouse Pond to assess the development of unbalanced aquatic conditions since 2009. The foci of the survey were to document current plant growth conditions and assess water quality parameters in order to evaluate the overall health of the ponds and develop a recommended management program for maintenance of ecological balance.

The following report will discuss: survey methodology, vegetation assemblage, water quality results, a summary of results and concerns, and management recommendations concentrated on rectifying conditions in Minister/Schoolhouse Pond.

SURVEY METHODOLOGY

A point-intercept survey methodology was employed to document and quantify aquatic vegetation growth within the waterbody. A georeferenced 40-m grid data layer was placed over an orthophoto of Minister/Schoolhouse Pond and data collection points were placed at each vertex, with a total of fifty (50) representative collection sites (Figure 1). A GPS was used to locate each data point in the field, with the following data collected at each point: aquatic plant species, relative density of each species, and overall density. The abundance scale, developed by the US Army Corps of Engineers and modified by Cornell University, was used to categorize total observed plant growth:

- T Trace: Finger-full on rake
- S Sparse: Handful on rake
- M Moderate: Rake-full of plants
- D Dense: Difficult to bring into boat



Water quality samples were collected at two locations within the pond, at the relative centers of each basin. The samples were analyzed for the following parameters: pH, turbidity, apparent color, true color, nitrate, ammonia, total phosphorus, dissolved phosphorus, chlorophyll A, total alkalinity, and algae identification and enumeration. Field testing of temperature and dissolved oxygen profiles was also performed at the two locations within the waterbody.

RESULTS & ANALYSIS

Vegetation Inventory

On June 7, 2017, a SÖlitude Biologist performed the detailed survey of Minister/Schoolhouse Pond – no invasive species were documented at the pond. Only 25 of the 50 points contained vegetation, of which 17 native species were identified within the pond (Table 1). Vegetation growth was spread throughout the pond with an average of three (3) species per vegetated point, and a maximum richness of six (6) species. Please see Appendix A for raw data. A list of plant species identified during the survey follows:

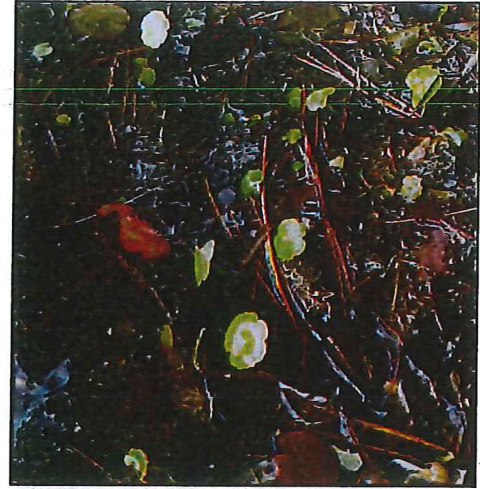
Table 1: Identified Vegetation Species	
Common Name	Latin Name
Watershield	<i>Brasenia schreberi</i>
Coontail	<i>Ceratophyllum demersum</i>
Spikerush	<i>Eleocharis</i> sp. likely <i>E. acicularis</i>
Western waterweed	<i>Elodea nuttallii</i>
Aquatic moss	<i>Fontinalis</i> sp.
Stonewort	<i>Nitella</i> sp.
Yellow waterlily	<i>Nuphar variegata</i>
White waterlily	<i>Nymphaea odorata</i>
Floating heart	<i>Nymphoides cordata</i>
Ribbonleaf pondweed	<i>Potamogeton epiphydrus</i>
Small pondweed	<i>Potamogeton pusillus</i>
Humped bladderwort	<i>Utricularia gibba</i>
Lesser bladderwort	<i>Utricularia minor</i>
Whorled bladderwort	<i>Utricularia purpurea</i>
Little floating bladderwort	<i>Utricularia radiata</i>
Common bladderwort	<i>Utricularia vulgaris</i>
Tapegrass	<i>Vallisneria americana</i>

Overall density of the pond was low, in-part due to the seasonality of the survey (Figure 2). White waterlily, yellow waterlily, and humped bladderwort were found most commonly throughout Minister/Schoolhouse Pond (Figure 3). Due to the early nature of the survey, the vegetation growth likely increased throughout the growing season at various locations within the pond.

The Minister and Schoolhouse basins displayed slight differences in vegetation distribution and species richness. The Minister basin supported 16 of the 17 aquatic plant species found within the pond, while the Schoolhouse basin only supported ten (10). As shown in Figure 3, western waterweed, tapegrass, lesser bladderwort, whorled bladderwort, spike rush, stonewort, and small pondweed were species only found in the Minister basin.



Emergent and wetland edge vegetation grew most prominently along the less developed edges of the pond. A small native population of pennywort (*Hydrocotyle* sp.) was located on the southeastern corner of the Schoolhouse basin, adjacent to the launch (pictured to right). The growth form was too young to speculate between whorled marsh pennywort (state protected) or many-flowered pennywort (common). Three stands of invasive common reed (*Phragmites australis*) were documented along the perimeter of the Minster basin in relation to point locations 1, 2, and 8. Common reed is an aggressive non-native wetland species that rapidly grows and spreads. Invasive species such as common reed are a significant threat to native vegetation buffers, especially small herbaceous species such as pennywort.



Water Quality

Water quality sampling was conducted in order to establish baseline data and identify potential management concerns. The following contains information regarding the 2017 sample analysis results along with more detailed descriptions of each parameter and their significance to the freshwater ecosystem.

Parameter	Minister basin	Schoolhouse basin
Turbidity (NTU)	2.0	1.7
True Color	26	20
Apparent Color	46	34
Total Alkalinity (mg CaCO ₃ /L)	7.10	7.40
pH	6.5	6.8
Ammonia (mg/L)	ND*	ND*
Nitrate (mg/L)	ND*	ND*
Total Phosphorus (mg/L)	0.034	0.039
Dissolved Phosphorus (mg/L)	ND*	0.013
Chlorophyll A (µg/L)	13.4	15.5
Secchi disk (ft)	4'2.5"	4'4"

*ND is a 'Non-Detect' result based off of the minimum value reading of a laboratory meter.

Turbidity is a relative measurement of suspended material in the water, measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values in most waterbodies rarely rise above 5 NTU. A value greater than 10 NTU indicates high suspended solids, often due to increased runoff, high inflow, or activities within the pond and/or the watershed. Suspended solids include soil particles (clay, silt, sand), algae, and plankton. Both samples low NTU, indicating very little suspended solids were present within the water column at the time of sampling.



Color is a visual parameter, separated into unfiltered (Apparent) and filtered (True) measurements.

Apparent color is the color of unfiltered pond water, caused by suspended and dissolved matter. This value can change drastically depending on weather conditions: increase with storm events, decrease with drought. There are four approximate categories for Color: 0-25 is clear, 25-40 is light tea-color, 40-80 is tea color, >80 is dark tea color. *The Minister basin categorizes at tea color, whereas the Schoolhouse basin measures at a light tea color. Some particulates fall out of suspension while water flows from Minister to Schoolhouse.*

True color is the color of filtered pond water, free of particulates; represents only dissolved organic matter (DOM) in the water column. This value can be subtracted from the Apparent color to determine the quality of water inputs. *The Minister basin measures at a light tea color, whereas the Schoolhouse basin measures as clear. At the time of the sampling, 56% of the color of Minister is DOM whereas DOM comprises 59% of the color in Schoolhouse.*

Alkalinity is a measure of buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Values below 20 mg/L typically illustrates susceptibility to pH fluctuation. The standard range for surface waters is 20-200 mg/L. *The sample results for both basins fall below the typical range, which is typical of the New England region and indicative that the system is more susceptible to acid additions and pH fluctuations.*

pH ranges from 0-14, where zero is extremely acidic, seven is neutral, and 14 is most basic. pH represents the concentration of hydrogen ions (H⁺) in solution. A range of 5.5-8.5 is best for maintaining a healthy fishery. A stable pH (± 1) is also important – fluctuations can adversely affect water chemistry and pond biota (fish, snails, plankton, plants, etc.). *Both basins fall within normal range.*

Nitrogen is a vital nutrient in the pond environment for plant and algae growth. Nitrogen exists in water as various compounds, influenced by the atmosphere, precipitation, biological activity, and water chemistry.

Ammonia is a measure of two constituents, NH₃ and NH₄⁺, and is a transitional product in the breakdown of organic nitrogen into nitrate. It is typically short-lived in the pond environment except under conditions of low dissolved oxygen. Waterbodies that have a high pH are susceptible to high ammonia concentration; the higher the pH, the more ammonia will be present within the water column. High levels of ammonia typically indicate a eutrophic pond, and can be toxic to fish at higher levels. Levels lower than 0.3 mg/L can limit plant and algae growth when occurring with low phosphorus levels. *Both basins measured Non-Detect at 0.075 mg/L at the time of sampling.*

Nitrate is another form of nitrogen found in the water column. Nitrate is usually the most prevalent form of inorganic nitrogen in the water and results from natural aerobic bacteria activity and fertilizer use. It is also the form that is most readily available for plant and algae growth. Levels less than 0.05 mg/L are ideal. *Both basins measured Non-Detect at 0.1 mg/L at the time of sampling.*

Phosphorus is considered a limiting nutrient for aquatic plant growth in freshwater systems. Unlike nitrogen, Phosphorus does not interact with the atmosphere and remains contained within the aquatic system.

Total Phosphorus measures both particulate and dissolved phosphorus, where particulate phosphorus is generally not biologically available for algae growth. Generally, a total phosphorus value over 30 parts per billion (ppb, or 0.03 mg/L) is the threshold where algal growth can be problematic. Aquatic systems at <12 ppb are considered nutrient poor and oligotrophic; 12-24 ppb



contain a moderate amount of nutrients and mesotrophic; 25-96 ppb are nutrient rich and eutrophic; >96 ppb contain excessive nutrients and hypereutrophic. *Both basins measured as mesotrophic at the time of sampling.*

Dissolved phosphorus remains in the water column, while particulate phosphorus settles to the lake bottom. Dissolved phosphorus is biologically available, and is used in aquatic processes such as plant and algae growth. *The Dissolved Phosphorus in the Minister basin was measured as Non-Detect at 0.02 mg/L and the Schoolhouse basin was measured at 0.013 mg/L, consistent with a mesotrophic status.*

Chlorophyll A is the most common type of chlorophyll in plants and algae that photosynthesize, or use sunlight to grow. Chlorophyll a can be measured as an estimate of phytoplankton within the water column, where concentrations are highest in the top portion of the water column, or the epilimnion. Measuring Chlorophyll A can indirectly monitor nutrient pollution from phosphorus and nitrogen, which can be indicative of eutrophication or potential water quality issues. 0-2.6 ug/L is oligotrophic, 2.7-20 ug/L is mesotrophic, 21-56 ug/L is eutrophic, >56 ug/L is hypereutrophic. *Both basins measure in the mesotrophic category.*

Secchi disk readings determine the clarity or turbidity of the water column in terms of depth, and can be used over consecutive years to analyze water quality trends. Secchi disk measurements can be used as one way to calculate the Trophic State Index (TSI) value of the waterbody. >4 m is oligotrophic, 4-2 m is mesotrophic, 2-1 m is eutrophic, <1 m is hypereutrophic. *Secchi depth readings for both basins were slightly deeper than one (1) meter, measuring as eutrophic.*

Dissolved Oxygen (DO) is important in aquatic systems. Aquatic fauna required adequate levels of oxygen, and the pond chemistry is also heavily affected by available oxygen. Values above 5.0 mg/L are desirable for most aquatic life, including most fish species, however lower values commonly occur near the sediment layer where oxygen and nutrient exchange are at a minimum. *See Figure 4 on the following page.*

Temperature – is one of the limiting factors for algae and plant growth; as temperature increases, biological activity (photosynthesis, respiration, and decomposition) increases to a point. Temperature is directly related to the amount of available dissolved oxygen, where warmer water holds less oxygen. In deeper waterbodies, temperature stratification occurs; a thermocline occurs at depth where the top layer is warmer and actively exchanges nutrients with the air. The bottom layer is distinctly cooler and isolated from surface impacts. *See Figure 4 on the following page.*

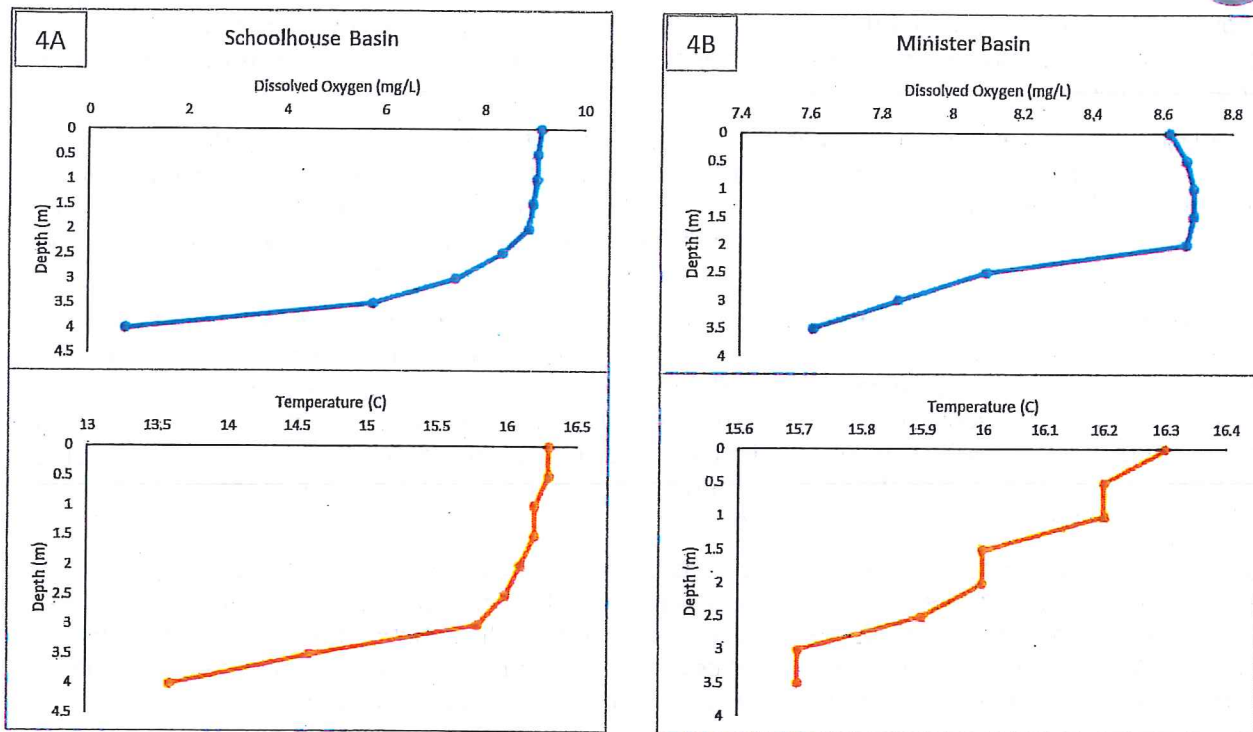


Figure 4A & B: Displays the profiles of Dissolved Oxygen and Temperature throughout the water column, surface to bottom.

At the time of the sampling, stratification had occurred in Schoolhouse basin with a thermocline between 3-3.5 meters depth, whereas the Minister basin was still in the process of mixing/settling.

Algae Identification and Enumeration is used to understand the planktonic-level biota within the waterbody. Algae are an important part of the aquatic food web, acting as primary producers while also providing a food source to zooplankton and planktivorous fish species, among other organisms. The identification of algae species within the surface water (epilimnion) can explain aspects of a waterbody such as odor, clarity, and turbidity. Very few species and low counts for both basins were analyzed at the time of the sampling, where some species suggest odors during potential bloom events. Please see Appendix B for the Identification and Enumeration report.

The water quality results classify Minister/Schoolhouse Pond as mesotrophic with eutrophic tendencies at the time of the sampling. The trophic status (Oligo-, Meso-, Eutro-, and Hypereutro-) is used to classify waterbodies in terms of their productivity, ranging from less productive to over-productive. Some nutrient loading seems to be occurring in the Minister basin and concentrating as the flow enters the Schoolhouse basin. A balance of nutrients is required for a sustainable ecosystem, where adequate biologically-available phosphorus is especially important as a driver for ecosystem health. An abundance of organic phosphorus can lead to phytoplankton blooms and speed the effects of eutrophication. Soft water can also challenge the promotion of a healthy fishery and help prevent the establishment of dense vegetation.

While mesotrophic at the time of sampling, aquatic conditions fluctuate throughout the season and are influenced by weather events, such as rain and wind, and any changes in the watershed. Additional sampling throughout the season is required for further analysis.



CONCLUSIONS & MANAGEMENT RECOMMENDATIONS

The elevated concentration of phosphorus and chlorophyll A, combined with the low secchi disk reading, are suggestive of increased productivity and future management issues. Low water clarity can inhibit excessive plant growth, while also deterring a balanced amount of native vegetation and phytoplankton necessary for pond and wildlife health.

We believe continued water quality monitoring is paramount to understanding the nutrient fluctuations occurring within the Minister/Schoolhouse Pond, and will ultimately proactively aid future management decisions. Since the two basins seem to have different turn-over seasonality (when stratification occurs), nutrient loading may also have variable consequence for each basin. We suggest four sampling sessions to outline the changes in water quality throughout the season, with a late-season point-intercept survey to monitor the extent of aquatic plant growth compared with the 2017 survey. This monitoring regime will document the seasonality of nutrient fluctuations for Minister/Schoolhouse Pond and potential nutrient loading affecting the pond.

Furthermore, we suggest management of the pioneer *Phragmites* infestation through the use of the herbicides Glyphosate or Imazamox. Due to the fecundity of *Phragmites* growth, herbicide use is the most selective and effective means of *Phragmites* control, especially in the early stages of an infestation.

Based on the potential nutrient influence and cycling, a future program addressing water quality remediation can prove proactive and preventative of further eutrophication. We have had success in reducing heightened levels of phosphorus through the use of Aluminum sulfate or Polyaluminum Chloride (PAC), which inactivates the bioavailable phosphorus within the water column.

We hope that you find this information helpful in making your pond management decisions. In the following section, we provide a breakdown of the estimated costs for the recommended management program. If you have any questions or need anything further, please contact our office.

ESTIMATED MANAGEMENT COSTS

Monitoring

- Comprehensive, point-intercept survey \$3,000
- Water quality and Algae sampling (4 sessions) \$4,000

Phragmites Management

- Spot Treatment of 3 small stands \$1,500
- Permitting through Town & State \$3,000

Nutrient remediation

- Both basins, through the use of Aluminum Sulfate/PAC \$5,000-7,500



Minister/Schoolhouse Pond

Eastham, MA

Survey Points

FIGURE:	SURVEY DATE:	MAP DATE:
1	6/7/17	9/8/17

Legend:

● Survey Points

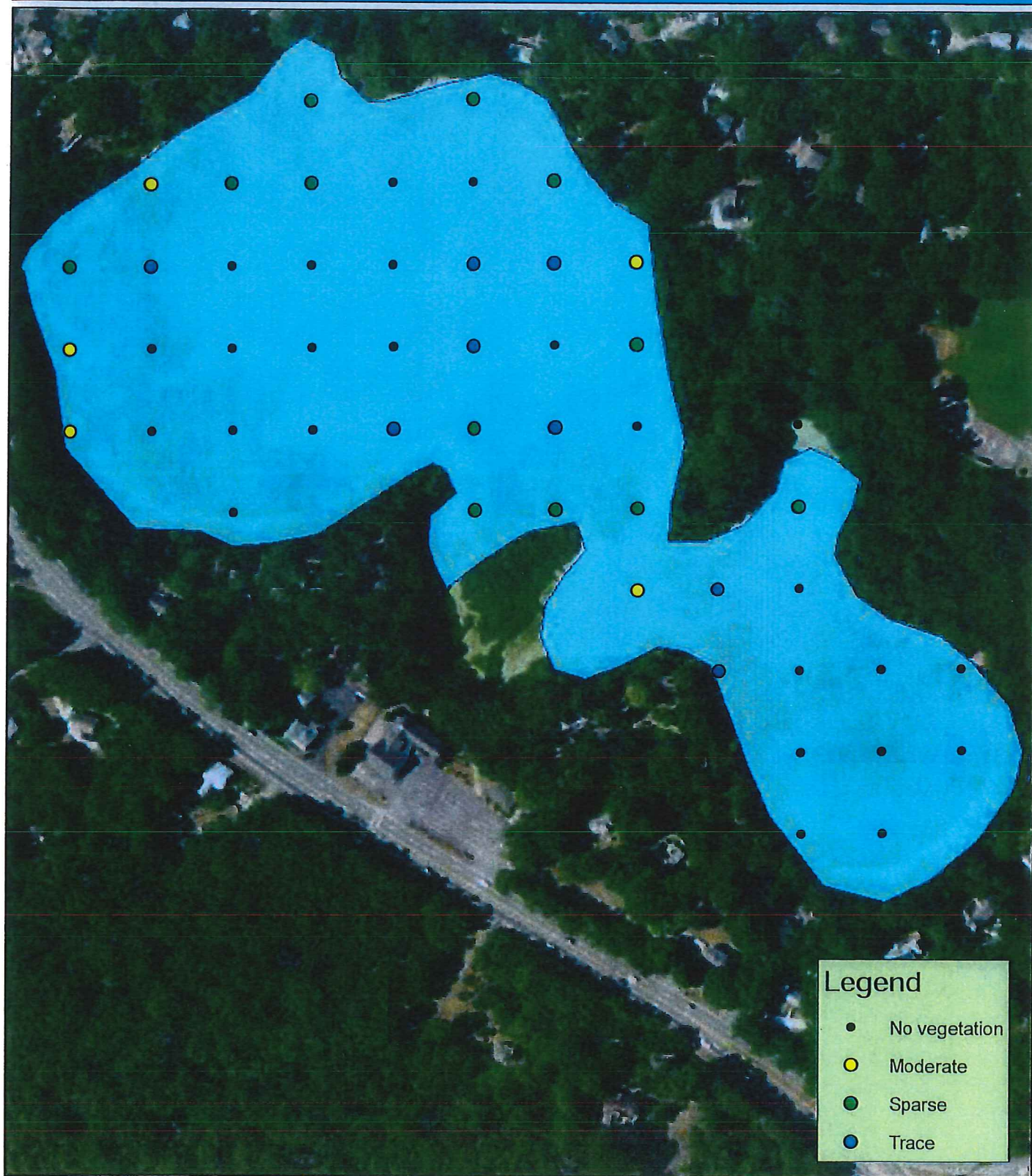


0 60 120 240 360 480 Feet

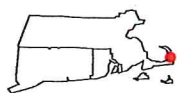
SOLITUDE
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590 LAKE STREET
SHREWSBURY, MASSACHUSETTS 01545
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WEB: WWW.SOLITUDELAKE.COM



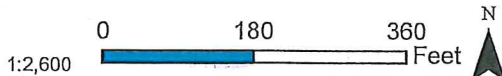
FIGURE 2: Overall Vegetation Density



Minister & Schoolhouse Ponds
Eastham, MA



Minister/Schoolhouse Pond



Map Date: 7/24/17
Prepared by: BNA
Office: SHREWSBURY, MA

APPENDIX A

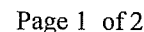
RAW DATA

Appendix A: Raw Data

[illegible]

APPENDIX B

ALGAE ID & ENUMERATION REPORT



BArvidson@solitudelake.com

Telephone: 860-828-9787 Toll Free (In State) 800-826-0105 (Out of State) 800-654-1230 Fax: 860-829-1050
CT Cert. #PH-0404 EPA Cert. #CT-024 USDA Cert. #0976 FDA Reg. #086650488 CT CSL #0000624

SOLitude Lake Management

590 Lake Street

Shrewsbury, MA 01545

EMAIL ADDRESS:


BArvidson@solitudelake.com

Report Date:	7/05/2017	Date Sampled:	6/07/2017
Laboratory ID#:	1770409-02	Date Received:	6/16/2017
		Date Tested:	6/26/2017
Sample Site: SURFACE WATER: SCHOOLHOUSE POND			

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

[illegible]

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 6/16/2017.

Approved by: 

Northeast Laboratories, Inc. 129 Mill Street Berlin, CT 06037 www.nelabsct.com

Telephone: 860-828-9787 Toll Free (In State) 800-826-0105 (Out of State) 800-654-1230 Fax: 860-829-1050
CT Cert. #PH-0404 EPA Cert. #CT-024 USDA Cert. #0976 FDA Reg. #086650488 CT CSL #0000624

EcoLogic Memorandum

TO: Jane Crowley, Town of Eastham Health Agent
FROM: Liz Moran
RE: Aquatic Evaluation at Minister/Schoolhouse Pond (SOLitude Lake Management)
DATE: November 13, 2017

Objective

At your request, EcoLogic reviewed the above-referenced report of the sampling and analysis of Minister/Schoolhouse Ponds conducted in 2017. SOLitude characterized the objectives of their aquatic evaluation as follows: *"...to document current plant growth conditions and assess water quality parameters in order to evaluate the overall health of the ponds and develop a recommended management program for maintenance of ecological balance."* (Page 1 of 7)

Background

In 2009, the Coastal Systems Group of the School of Marine Science and Technology (SMAST) and the Cape Cod Commission reported on the water quality status of freshwater ponds in the Town of Eastham¹. The report reviewed the results of six years of volunteer water quality monitoring of 10 ponds, evaluated the ecological status of the ponds, estimated water and phosphorus budgets, and recommended next steps. Six of the freshwater ponds were reviewed in greater detail. The six ponds, selected by the Town of Eastham Water Resources Advisory Board, included Great, Herring, Muddy, Depot, Minister and Schoolhouse. The 2009 report concluded that Minister and Schoolhouse Ponds are impaired by elevated phosphorus, that the ponds (although shallow) develop thermal layering during summer, and that the amount and significance of sediment phosphorus flux to the overlying water column are undetermined.

In 2011, GHD and EcoLogic LLC completed an Action Plan for the Eastham inland ponds, providing guidance to the Town officials and boards regarding measures to reduce phosphorus inputs to the ponds and the potential efficacy of remedial measures. One conclusion of the 2011 Action Plan was that Herring Pond and Great Pond were high priorities for water quality protection and/or remediation. The designation of these ponds as priorities considered three factors: documented water quality and ecosystem impairment, projected future conditions without intervention, and the extent to which remedial actions would benefit the public.

¹ Eichner, E. 2009. Eastham Freshwater Ponds: Water Quality Status and Recommendations for Future Activities. Coastal Systems Program, School of Marine Science and Technology, University of Massachusetts Dartmouth and Cape Cod Commission. New Bedford and Barnstable, MA. 155 pp.

In October-November 2012, GHD, EcoLogic, and Aquatic Control Technologies (now part of SŌLitude Lake Management) led an alum treatment program of Herring Pond. In 2013, the team implemented an alum treatment program of Great Pond. Subsequent water quality monitoring confirms that both alum treatment programs were successful. A recently-published article in an international journal of lake management included the positive results of the Herring Pond and Great Pond treatments among the case studies of alum treatment programs on Cape Cod.²

Eastham residents, officials, and resource managers expressed their concerns about the shallower ponds throughout the planning process. There is a need to identify effective interventions that can address the symptoms of eutrophication in these ponds. The Minister/Schoolhouse Pond complex was identified as a high priority for a next phase of public investment in pond remediation. Annual PALS monitoring results confirm that these water bodies continue to be impaired with respect to state criteria for phosphorus, chlorophyll-a, and dissolved oxygen (DO) depletion of the lower waters.

Various alternatives for restoring water quality and habitat in Minister/Schoolhouse Pond have been considered. In the 2011 Action Plan for the Eastham Kettle Ponds we identified enhanced water circulation as a potentially feasible alternative, and specified the SolarBee® technology. Our project team filed for and received an Order of Conditions from Mass DEP for deployment of the solar-powered mixing devices. However, due of the costs and uncertainty associated with the efficacy of the SolarBee® technology, the Town deferred action on installing SolarBee® units in Minister/Schoolhouse Pond until there was more experience with this technology on Cape Cod ponds.

In 2013, concerned local citizens suggested installing wind-powered air compressors adjacent to Minister/Schoolhouse Pond, and piping compressed air to diffusers placed on in the deep basins. The concept is similar to the solar-powered mixing devices; preventing anoxic conditions at the sediment surface would prevent chemical changes that result in the release of sediment-bound phosphorus to the overlying water where it is available to support phytoplankton growth. Both GHD and EcoLogic concluded that the concept of wind-powered compressors and injection of air via diffusers has merit, but would require a detailed engineering and environmental analysis. In July 2015, the Friends of Minister and Schoolhouse Ponds requested support from the Town to explore additional remedial approaches: alum treatment, aeration/mixing using SolarBee® or windmill, and macrophyte removal by power raking.

At the Town's request, EcoLogic commented on the presentation from the Friends of Minister and Schoolhouse Ponds in a memo dated August 3, 2015 ([attachment 1](#)). We recommended that the Town contact Aquatic Control Technologies (now SŌLitude Lake Management) to learn what remedial measures for shallow ponds had proven successful in their practice. The firm completed a field

² Wagner, K.J., D. Meringolo, D.F. Mitchell, E. Moran, and S. Smith. 2017. **Aluminum treatments to control internal phosphorus loading in lakes on Cape Cod, Massachusetts**. *Lake and Reservoir Management*. 33(2):171-186.

evaluation of the ponds condition in June 2017, and recently submitted their report of findings and recommended next steps.

2017 Findings

Field biologists from SÖLitude Lake Management collected water samples and surveyed the aquatic macrophyte community of Minister/Schoolhouse Pond in early June, 2017. They reported a relatively diverse assemblage of native macrophyte species in the ponds. Overall plant density was low, likely due to the timing of the survey early in the growing season. No invasive macrophyte species were detected within the ponds, although three small stands of *Phragmites* were identified along the shoreline of Ministers Pond.

Results of the June 2017 water quality testing were generally consistent with the historical PALS data. Total phosphorus concentrations were elevated compared to ecoregional criteria; with measurements in excess of 0.030 mg/L. The report does not specify the depth at which the samples were collected. The PALS data are collected at two depths: 0.5 m and 3.0 m. The deeper samples collected in both basins are consistently higher in TP compared to the shallow samples, usually by an order of magnitude, indicating phosphorus flux from sediments.

Chlorophyll-a data were lower in the early June sampling (13-15 µg/L) compared with the long-term average PALS results (20-25 µg/L) which are collected later in the summer. Microscopic analysis of the phytoplankton revealed an assemblage dominated by diatoms and green algae. This result is consistent with the annual cycle of phytoplankton dominance; diatoms are prevalent in the spring as they tolerate cold temperature and low light conditions, followed by a shift in dominance toward green algae in early summer, and often followed by an increased importance of cyanobacteria in late summer and early fall when the waters are warmest.

Comments on Recommendations

The report by SÖLitude Lake Management recommends the following:

- Continue water quality monitoring to understand nutrient dynamics
- Conduct a late season macrophyte sampling program to document the extent of impairment
- Treat the shoreline *Phragmites* infestation with herbicides
- Consider an in-lake treatment using aluminum sulfate (alum) or polyaluminum chloride (PAC) to inactivate bioavailable phosphorus within the water column, once the sources and cycling of phosphorus are better defined.

EcoLogic supports the recommendation for continued investigation of nutrient sources and cycling. We encourage the Town of Eastham to remain in the PALS program. If additional water column testing is undertaken by SÖLitude Lake Management we suggest that phosphorus samples be collected at 0.5 m and 3 m depths, to ensure maximum comparability with the PALS data and enable a calculation of

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sediment flux. Samples collected over the stratified period (e.g., mid-June through late September) will provide information about the magnitude and significance of phosphorus released from sediments.

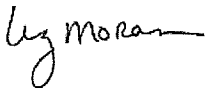
In addition, we recommend sediment testing to assay the iron-bound phosphorus present in the sediment overlying water depths greater than 2.5 m (the depth of thermal layering). These data were key to the successful design and permitting of alum treatment programs for Herring Pond and Great Pond.

We fully support the attempt to eradicate the pioneer *Phragmites* infestation. Rapid response is essential for responding to this invasive species.

Finally, we recommend continued engagement with the abutters and Friends of Minister and Schoolhouse Ponds to discuss their perceptions of the ponds' water quality with respect to use attainment. Is the primary concern macrophytes or algae? The recommendation to include a later season survey of the ponds' macrophyte community can help inform this discussion. We note that some of our clients have recently begun using aerial drone surveys to photograph and document macrophyte coverage. If this is of interest to the Town, we suggest discussing this capability with SÖLitude Lake Management.

The NY Finger Lakes experienced unprecedented cyanobacteria in the very warm summer of 2017. Based on our experiences supporting clients responding to this situation, we recommend that all resource management agencies adopt plan for surveillance and rapid response to this public health issue.

Thank you for the opportunity to review the report. Please let me know your questions and comments.

A handwritten signature in cursive script, appearing to read "Elizabeth C. Moran".

Elizabeth C. Moran, Ph.D.

EcoLogic Memorandum

TO: Jane Crowley, Town of Eastham
FROM: Liz Moran
RE: Minister and Schoolhouse Ponds, evaluation of alternatives
DATE: August 3, 2015

At your request, I reviewed the PowerPoint file prepared by the Friends of Ministers/Schoolhouse (M/S) Ponds. Clearly, these shallow ponds continue to exhibit symptoms of excessive eutrophication and remain a high priority for restoration. Based on the presentation, the primary concern of the M/S abutters seems to be macrophytes, not algae (phytoplankton). This is an important distinction, since our approach to alleviating the symptoms depends on whether weeds or algae represent the greater impairment to recreational use. The residents cited various approaches—alum treatment, aeration/mixing using SolarBee® or windmill, and macrophyte removal by power raking. This brief memo summarizes my thoughts on these restoration alternatives.

Alum Treatment

I recently sent you an article reviewing the effectiveness of alum treatments to six shallow lakes; results were mixed but overall positive. However, lakes with substantial macrophyte communities were the least likely to demonstrate improvements from an alum treatment program. The authors hypothesize that the standing crop of macrophyte biomass contributes enough phosphorus to keep the water column concentrations high, thus supporting continued algal blooms. This could affect the efficacy of an alum treatment program for M/S. The ponds have a maximum depth of about 13 ft. Secchi disk is variable, averaging around 1.3 m (4.3 ft.). A rule of thumb is that the photic zone (depth to which photosynthetically-active light can penetrate to the sediment surface) is about twice the Secchi depth, which is about 8.6 ft. in these ponds. Macrophytes are probably present up to a water depth of approximately 10 ft.—bathymetric maps of the two ponds are included at the end of this memo.

In Herring & Great Ponds, we applied alum to the deeper waters (>20+ ft.), where oxygen remained near zero at the sediment surface over the summer stratification period. This design effectively treated the sediments where phosphorus would be released to the overlying waters. Moreover, the benthic community present in these deep areas is typically very limited (both in number of species and abundance of organisms). Consequently, the potential for adverse impacts on the pond's aquatic life from alum application is low. This line of reasoning was acceptable to state and local reviewers/approving Boards and agencies.

The ponds do not appear to be good candidates for an alum treatment program. Some additional data and information would support a more definitive assessment- including:

1. More information on the macrophyte community- density and depth to which they are present, and whether any are considered to be rare, threatened or endangered.

2. Sediment testing for iron-bound P content—we did this testing in Great & Herring Ponds prior to the alum treatment; Spectrum Analytical in Agawam MA has this analytical capability.
3. More frequent measurements of chlorophyll-a in the water column (to evaluate algal abundance)
4. Discussions with abutters and other users of Ministers and Schoolhouse Ponds regarding the factors affecting their ability to use and enjoy the resource.

Aeration/Enhanced Circulation

In the 2011 Action Plan for the Eastham Kettle Ponds we identified enhanced water circulation as a potentially feasible alternative for Ministers and Schoolhouse Ponds, and specified the SolarBee® technology. It is certainly fair to characterize our recommendation as “lukewarm”; prior experiences with SolarBee® application have been inconsistent. A SolarBee deployment on the 2 ponds did receive an Order of Conditions by MASS DEP; this order will expire in December 2015 (unless an application for an extension is filed). Because of the costs and uncertainty, the Town went ahead with the alum treatment programs on Herring & Great Ponds as a priority, and deferred action on M/S until there was more experience with SolarBee® deployments on the Cape. Multiple units were installed in Santuit Pond to help improve water clarity which is degraded by persistent algal blooms. Based on information from colleagues and limited news reporting, water clarity has increased slightly on Santuit Pond following SolarBee® deployments, but still remains low.

Mr. Charles Harris also proposed enhanced circulation using windmills as the source of power. The Town of Eastham, GHD, and EcoLogic have previously offered comments on this proposal- this is an excerpt from my memo of December 2013:

...I concur with Mr. Harris that using the wind as an energy source to oxygenate and mix a shallow pond is a similar approach, and might bring the same benefits. Unfortunately, windmills and air pumps can be noisy and visually intrusive. It is not clear from the analysis how the diffuser lines would be placed on the pond bottom, and how effective they would be in achieving a consistent oxygen transfer or in circulating the water. Further investigation and analysis are needed to design the diffuser array, calculate oxygen transfer, and estimate impacts on water circulation. The time frame for projected improvements seems somewhat arbitrary. The applications of this technology cited by the vendor are primarily for agricultural uses, not for natural waters. More information and case studies are needed to evaluate whether this might be appropriate for the shallow Eastham ponds.

As in the alum treatment alternative, if macrophytes are the primary cause of impairment to lake recreational use, SolarBee® is not likely to be an effective control measure.

Hydraulic/power raking

This alternative would directly address impairment by excessive macrophyte abundance. As summarized in the ***Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in***

Massachusetts¹ and other references, hydroraking is a non-selective method of aquatic plant control. Hydroraking uses a floating backhoe-like machine equipped with a raking device that digs into the lake bottom, ripping out plants and their roots along with other benthic material including submerged stumps. This macrophyte control method is particularly effective for water lilies (white or yellow) and other species with dense root masses. Significant sediment resuspension and turbidity, and fragmentation of plants are possible. These machines are generally deployed in areas that are shallow and choked with macrophytes, such as canals, marinas, and embayments. The cost of hydroraking ranges from \$1,500 to \$4,000 per acre. Overall, hydroraking is a costly method that has potential for adverse environmental impacts.



Hydroraking (photo - Allied Biological Inc.)

Several permits and approvals would be required to implement this alternative on Minister /Schoolhouse ponds. The following summary is an excerpt from the Massachusetts FGEIR cited above (page 4-42):

“In addition to the standard check for site restrictions or endangered species (Appendix II), a Notice of Intent must be sent to the Conservation Commission with a copy to the Department of Environmental Protection Regional Office. If the proposed project occurs within an Estimated Habitat of Rare Wildlife in the most recent version of the Natural Heritage Atlas, a copy of the Notice of Intent must be submitted to the Natural Heritage and Endangered Species Program (NHESP) within the MDFG for review (Appendix II). If the proposed project occurs within a Priority Habitat of Rare Species in the most recent version of the Natural Heritage Atlas, the project proponent must submit project plans to the NHESP for an impact determination. An Order of Conditions must be obtained prior to work. For hand harvesting, a Negative Determination of Applicability might be obtained from the Conservation Commission, but an Order of Conditions could be required.

¹ Mattson, M.D., P.J. Godfrey, R.A. Barletta and A. Aiello. 2004. Eutrophication and Aquatic Plant Management in Massachusetts. Final Generic Environmental Impact Report. Edited by Kenneth J. Wagner. Department of Environmental Protection and Department of Conservation and Recreation, Executive Office of Environmental Affairs, Commonwealth of Massachusetts.

"Additional permit needs are highly dependent on the details of the project and the features of the lake, and to some extent, are a function of MDEP policies under review. Usually no MEPA review is required (Appendix II). Under current regulations a 401 Water Quality Certificate may be required for some types of harvesting, but this depends on ACOE policy implementation. In some cases an ACOE 404 permit and 401 Water Quality Certificate may be required for hydroraking projects (contact the Army Corps of Engineers for current policy). A Chapter 91 Permit is generally not required for harvesting in Great Ponds, provided that sediments are not removed (other than incidental amounts attached to roots of plants) or water depths altered. Hydroraking or rotovating in a Great Pond, however, may require a Chapter 91 permit by virtue of potentially major sediment disturbance; the need for this level of regulation is under discussion".

Controlling inputs

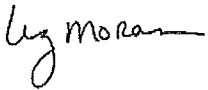
As we have discussed, continued focus on mitigating stormwater runoff into the ponds is an essential component of mitigating the impaired conditions in Minister/Schoolhouse. It is encouraging that the state DOT continues to engage with the Town to define feasible alternatives to redirect runoff from Route 6.

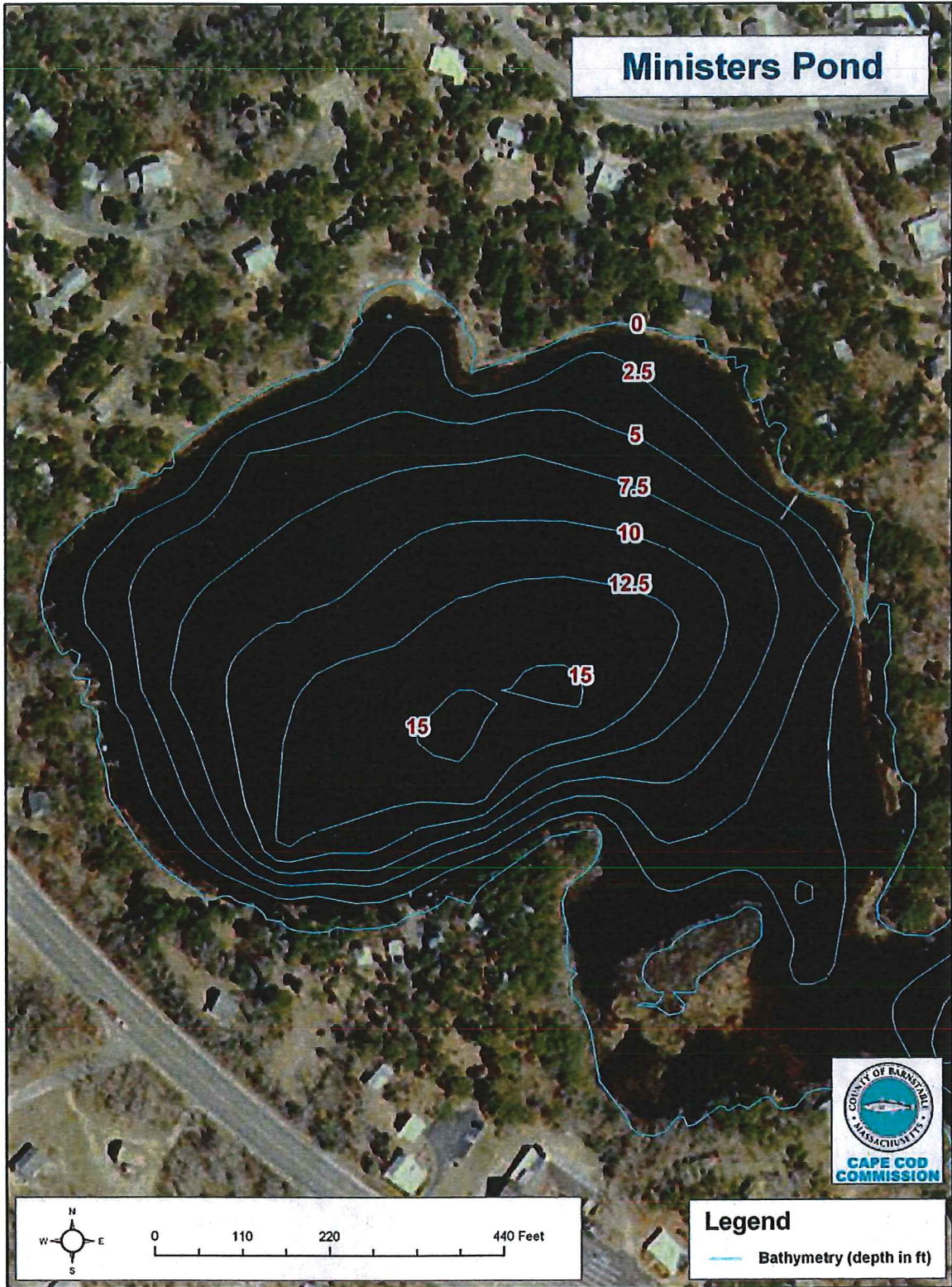
Recommendations

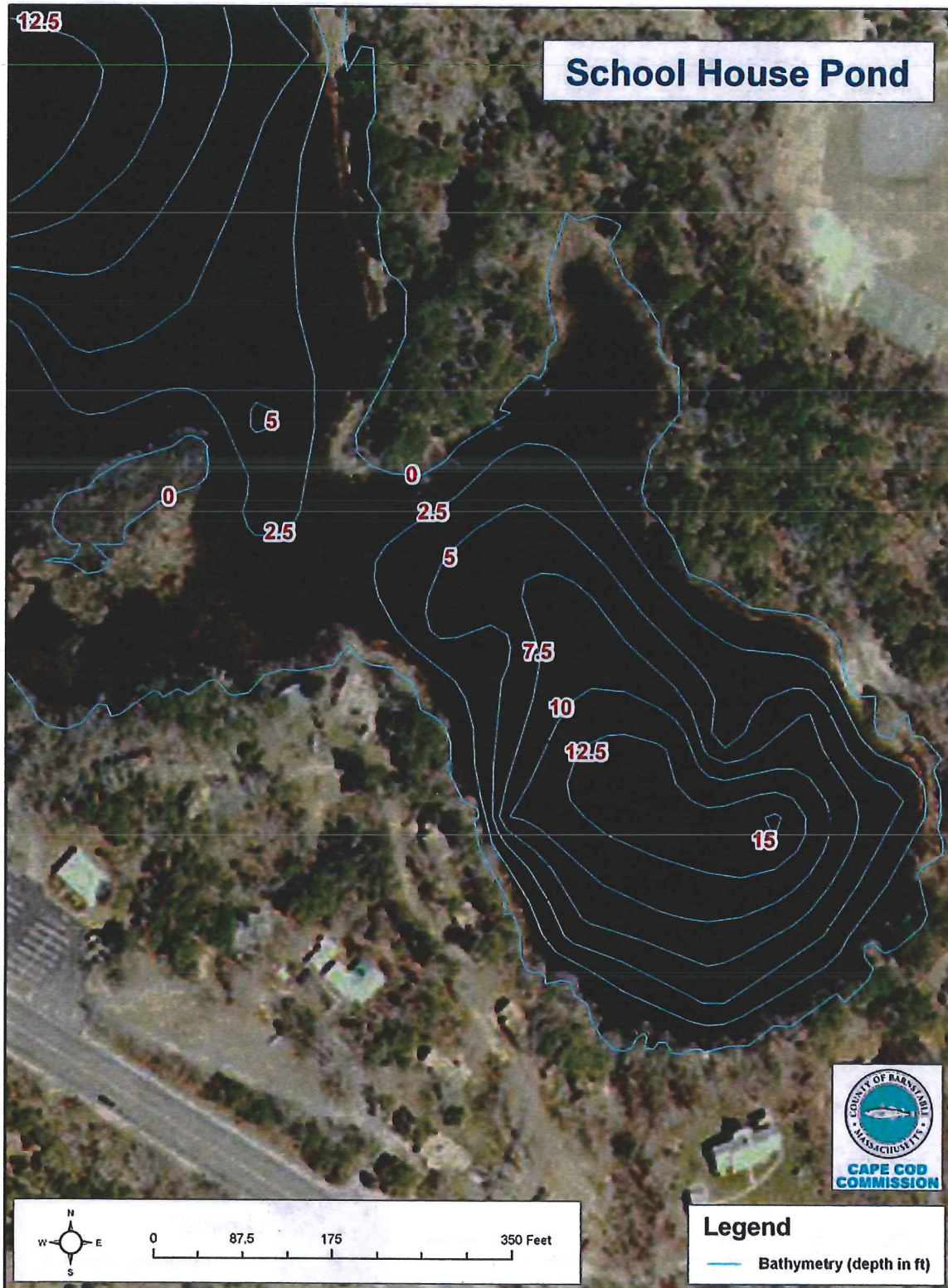
Additional discussion with the Minister/Schoolhouse abutters will be helpful to identify the primary concern, weeds or algae. This discussion will help us move ahead with refining the list of feasible alternatives. If excessive algal growth is the primary issue, then we should collect sediment samples and assay for iron-bound phosphorus, to help determine the potential efficacy of an alum treatment program. If macrophytes are the primary source of impairment, a survey of the plant community would be helpful to identify nuisance species and evaluate whether there are any protected species present that might limit the use of remedial measures. It might be helpful to consult with Aquatic Control Technologies to find out what other control measures are being deployed in the state along with their costs and benefits.

Please let me know if you have any additional questions and how we can help communicate information among the Town officials and the concerned residents.

I look forward to coming to Eastham next month to work with you on the salt water TMDL issues.







Schoolhouse Pond, Eastham MA



Setting

Pond Size: 6.8 acres; Maximum Depth: 13 ft.

Watershed Size: 5.7 acres

Public Access: Launch off Schoolhouse Road.

Uses: Swimming, fishing non-motorized boating

Fish community: warm water

Data: PALS, Eichner 2009, EcoLogic 2011

Current Conditions

- Impacted by human activities
- Occasional stratification and low oxygen may allow sediment phosphorus release.
- Major phosphorus sources: Birds (26-46%), roads (18-26%), precipitation (14-21%); input from Minister Pond (amount not known)

One septic leach field within 300 ft. upgradient.

- Minister Pond receives phosphorus load from watershed upstream of Schoolhouse Pond

Outlook for Future

- Occasional stratification and low oxygen conditions will continue to allow sediment phosphorus release.
- Phosphorus concentrations appear stable.

Recommended Actions

Watershed Best Management Practices (BMPs):

- Very limited watershed area, affected by conditions in Minister Pond



Schoolhouse Pond Water Quality Summary

Water Column	Parameter	Result ¹	"Healthy" Ponds Thresholds ²
Upper Waters	Total Phosphorus	23 µg /l	≤10 µg/l
	Chlorophyll-a	22 µg /l	≤1.7 µg/l
	Secchi Disk Transparency	1.3 m	Not calculated
Lower Waters	Total Phosphorus (<i>maximum average</i>)	65 µg /l	--
	Dissolved Oxygen (<i>minimum average</i>)	0.20 mg/l	--

¹Annual average results; Total phosphorus and chlorophyll-a, 2008-2010; Secchi disk transparency and dissolved oxygen, 2007-2010.

²Cape Cod Commission 2003. Table 5. Based on lower 25th percentile of 2001 Snapshot (all ponds). Secchi disk transparency not calculated due to multiple observations of disk visible on the bottom.

January 2018

Dear Members of the Eastham Board of Selectmen, Board of Health and Water Management Committee,

We are members of the Bayberry Hill Condominium Association, owners of a small group of cottages abutting Minister/Schoolhouse Pond. We are very concerned about the continuing deterioration of the Pond and would like to do what we can to help bring about action to address the health of our Pond.

We are pleased to see a broadly-based public meeting convened about our Pond. We have followed the public discussions and studies regarding the Pond over the years, attended meetings, and voiced our concerns and we appreciate all that has been done so far toward understanding the problems at issue. We understand that testing/studies of the Pond began as early as 2003, with the most recent study results issued in October 2017. While we know that Minister/Schoolhouse Pond was not the only pond in Eastham with identified problems, we are concerned that after over a decade of study, there have been no steps instituted for actual remediation.

We understand that studies and lay observation have revealed several elements causing problems and complicating remediation, including runoff of polluted wastewater, the shallow nature of the pond, and a need to preserve protected wildlife. We appreciate that the situation is further complicated by various ownership of the surrounding property by the Town of Eastham, the Massachusetts State Highway authority and private owners. We also understand that several types of remediation have been considered, including alum, Solar Bee, and dredging, and that each of these approaches have positive and negative aspects. We know that experts have been retained for many years to solve this complex problem. Yet we are discouraged that nothing has been done to slow, stop, or reverse any of the identified issues.

We are willing to do what we can to restore the Pond to good environmental health, so please let us know specific ways we can assist in data collection or help cure any of the existing problems.

We look forward to hearing more about the Pond at the meeting on January 17, 2018. We thank you, in advance, for sharing the timeline the Town of Eastham and its hired scientists establishes for the final accumulation of needed data and the anticipated date that remedial steps will begin.

Respectfully,

Members of the Bayberry Hill Condominium Association

